ITS Field Operational Test Summary

Capital

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Introduction

The Capital ITS Field Operational Test focused on determining whether in-vehicle cellular phones could be used to provide traffic information in a more cost effective manner than traditional methods. Test personnel compared the cost of traffic flow information obtained using cellular phones to the cost using the existing system of induction loops and video cameras.

The specific objectives of the study were to:

- Determine the accuracy and completeness of traffic information derived from cellular phone geolocation data.
- Determine if traffic flow information obtained by triangulating in-vehicle cellular phone signals can be effectively integrated into a real-time wide-area traffic management system.
- Determine the costs associated with deploying such a wide area traffic monitoring system.

The test took place in the Washington D.C. area and covered a period of 27 months, ending in November 1995.

Project Description

The test installed commercially available direction finding equipment on approximately one fourth of the Bell Atlantic Mobile cellular towers in the test coverage area. Figure 1 shows the test coverage area and the location of the equipment for the direction finding system (DFS) and the Transmission Alert System (TAS). The TAS detected call initiation messages from cellular phones. The DFS attempted to accurately determine the position of vehicles using cellular phones by triangulating the cellular phone signal information obtained from at least four position fixes. During the cellular phone call, the system calculated one or more additional transmitter locations. Using multiple locations of the same cellular phone unit, a software algorithm calculated the vehicle speed. Using the calculated speeds from several vehicles in the same section of highway and comparing their calculated speeds to a database of “normal” speeds, another algorithm determined the likelihood of a traffic incident. In this manner, the system attempted to derive information similar to that obtained by induction loops and video cameras.

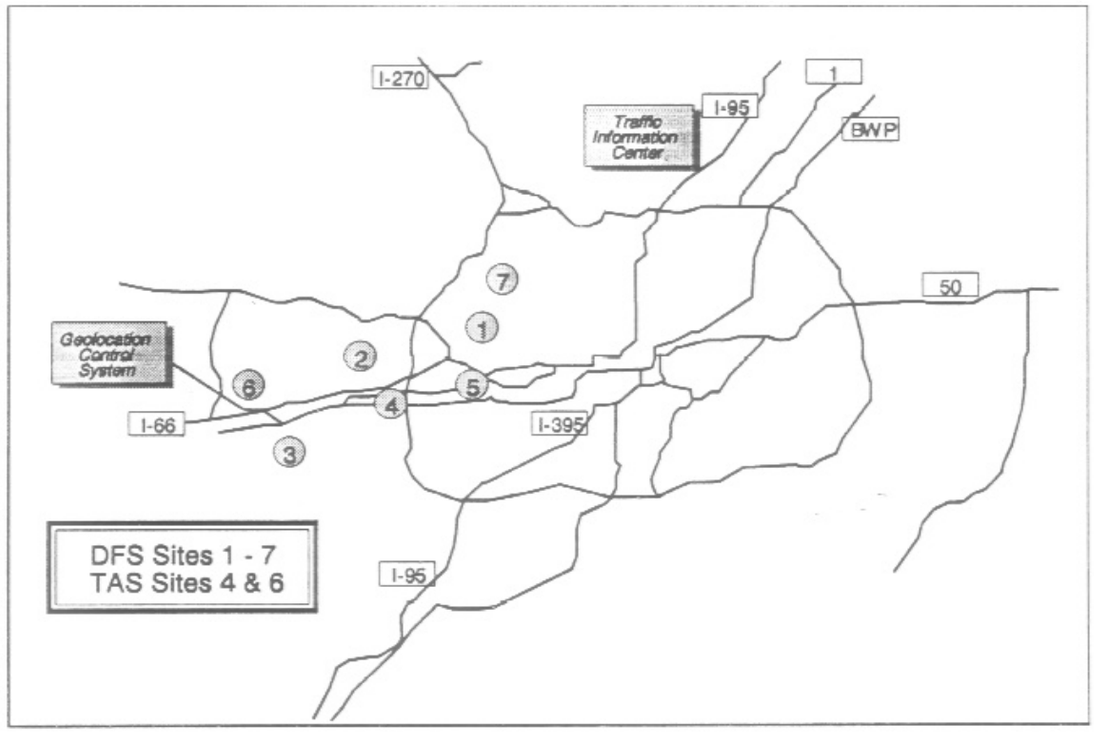

Figure 1: Test Area with Location of Direction Finding Equipment

The system included several methods to obtain accurate location information. To establish the accuracy of a single triangulation (fix), test personnel made cellular phone calls from known locations. The system then calculated the location of these "known" signals and used this information to calibrate other location information. In order to validate the accuracy of the speed calculations, test personnel drove five test vehicles with cellular phones through the area. Test personnel then compared the electronic driving logs to the speeds calculated by the system. The test also triangulated signals from cellular phones aboard random cars. Test personnel compared the resulting series of speed readings to police records of incidents in that area.

The test evaluated the system based on several factors: the accuracy and completeness of the data, the determination of the appropriate roles for the information, the determination of system costs and capabilities, and the public acceptance of the system.

Results

The Capital test was designed with high transmission power cellular phone technology in mind. During the test, however, new phones with substantially lower transmission power became prevalent. In an effort to adapt the test equipment to the new technology, the original test area was reduced to enable closer spacing of the direction finding equipment.

The system was able to determine vehicle location with reasonable accuracy. Using the minimum of two towers for triangulation, the system could calculate the location of a vehicle to within 150 meters. Using a third tower improved the accuracy to 108 meters. Tests with a moving vehicle confirmed that the system could distinguish traffic on highways from that on parallel and/or nearby arterial roads.

The system encountered problems when determining speed. Although the algorithm discarded some obviously erroneous readings and averaged at least three speed readings, the errors were large enough to invalidate 80% of all speed data.

Likewise, the automatic incident detection based on speed readings proved unsatisfactory. This was mainly because normal congestion produced very similar readings to readings measured during incidents. The evaluation found, however, that the speed readings could help an operator judge the traffic flow and detect incidents.

Test personnel compared the costs for the Capital system to the actual costs of the induction loop detection system on a representative part the highway network. They calculated that to provide a service similar to Capital in the 192 sq. mile area of the Washington DC-Baltimore corridor would require equipment installation at 23 towers. Such an installation would cost $2.7 million. An equivalent array of induction loops would cost at least $2.8 million (including work zone traffic control). Test evaluators noted, however, that induction loops provide additional capabilities (such as signal timing information) that the cellular system cannot provide. Test evaluators did not precisely calculate operation and maintenance costs so no comparison can be made.

Legacy

The operation of the system was discontinued at the conclusion of the test. No follow-up tests are currently planned. The technology used in this test has been superseded by the evolution of cellular phone technology.

Test Partners

Bell Atlantic Mobile Systems

Federal Highway Administration

Maryland State Highway Administration

P. B. Farradyne

Raytheon E Systems

Virginia Department of Transportation

References

Transportation Studies Center of the University of Maryland, Final Evaluation Report for the CAPITAL ITS Operational Test and Demonstration Program, May 1997